

HAZARDOUS EXPOSURES AND INJURY TYPES ASSOCIATED WITH THE USE OF INDUSTRIAL LIFT TRUCKS IN SWEDEN 2005-2007

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ABSTRACT

The full text describing the total number of occupational injuries related to industrial lift trucks, reported to the Swedish national workers' compensation insurance over the three years 2005, 2006 and 2007 was subjected to an in-depth analysis.

Industries like Metal Processing and Manufacturing (30%), Trades and Sales(24%) and Transport (15%) represented the majority of injuries. Storage Assistants (28%), Machine and Process Operators (18.5%) and Forklift Truck Drivers (18%) were the most common occupations in the material.

The main exposure scenarios were identified with the help of SAS Textmining® software as "handle, adjust, repair; goods, material" (14%), "step into/out of" (13.5%), "driving lift truck" (53.5%), "hit by lift truck" (19%). The exposure scenario dominating the injury material for all industries and occupations was "driving lift truck" (48-62% of all injuries) and further text analysis revealed that a large part of these injuries are related to the industrial lift truck being an unsafe vehicle and the driver's position lacking safety features.

It is suggested that industrial lift truck design should adopt and develop relevant aspects of the vehicle safety technology.

1 BACKGROUND

Industrial lift trucks, mostly referred to as forklift trucks, represent a substantial part of the severe occupational injury problem in the manufacturing, agricultural and transport industries (Stout-Wiegand 1987; Larsson, Rechnitzer 1994; Born et al 1996; Janicak, Deal 1999; Collins et al 1999a).

In spite of the increased focus on forklift operator training, truck dynamic stability and roll-over prevention, improved traffic engineering and the introduction of intelligent transport systems in manufacturing, the lift truck continues to be a major contributor to occupational fatalities and severe injuries in modern industrial environments (Collins et al 1999b; Koutchouk et al 2002; Larsson et al 2003; Horberry et al 2004; Railsback, Ziernicki 2009; Larsson et al 2010b).

The versatility and usefulness of the industrial lift truck implies sustained and, in new industrially developing areas, increased levels of exposure to the human-machine interaction represented by this type of vehicle. A more detailed analysis of exposures and events preceding occupational injuries related to the use of lift trucks could serve the purpose of providing manufacturers and industrial safety managers with better specifications for the design of trucks and their operational areas, and this could possibly reduce the incidence of injury.

In the following, the total number of occupational injuries related to industrial lift trucks in Sweden, as reported to the National workers' compensation insurance over the three years 2005, 2006 and 2007 was subjected to an in-depth analysis.

2 METHOD

The No-fault Liability Insurance for Occupational Injury with AFA Swedish Labour Market Insurances, the National workers' compensation insurance of Sweden, is a collectively bargained insurance owned jointly by employers and unions which covers around 97% of the Swedish workforce (including non-union members); more than 4 million people in public and private employment. The insurance, the reports to which have been used in this study, covers virtually all Swedish workplaces where there are industrial lift trucks. From a statistical viewpoint, this injury data could be considered the total National material for the years 2005 – 2007. However, the relative time of exposure to the estimated 70 000 industrial lift trucks in Swedish industries - by the different occupational groups in different industrial operations - is not known. The average age of the lift truck population, and the proportion of the population retired each year, is unknown. There are around 150 000 licensed industrial truck drivers in Sweden and some 30 000 new licenses issued every year – the exact numbers and their distribution over occupations are unknown.

The size of the total occupational populations is published in the National statistics (Statistics Sweden 2010). The occupational groups exposed to industrial lift trucks in Sweden, and identified in the claims material, represent 26% of the total National workforce; around 1 000 000 employees.

Occupations	Workforce 2007
Storage assistants (SSYK 4130)	58178
Machine and process operators (SSYK 8111-8290)	268892
Forklift truck drivers (SSYK 8334)	10232
Lorry drivers (SSYK 8323)	5586
Repair workers (SSYK 7211-7243)	127573
Manual order pickers (SSYK 9320)	32517
Construction workers (SSYK 7121-7139)	163869
Cashiers (SYK 4211)	15833
Sales reps (SSYK 5221)	63996
Other occupations exposed	327275
Total National workforce	4069700

Table 1 Occupations, incl statistical code, represented in the claims material and the total number of employed with an identified occupation in 2007 (Statistics Sweden 2010).

The exposure to industrial lift trucks, measured in time over the working day, varies considerably between different industries, occupations and tasks; only a few occupational groups use or drive lift trucks for the major part of the working day (e.g. Storage Assistants, Forklift Truck Drivers).

All injuries in the AFA claim files identified as related to “industrial lift truck, forklift truck” and reported in the years 2005, 2006 and 2007, were chosen for analysis (in September 2010). The claims were analyzed in terms of distribution over industries and activities, occupations, and injury severity. The claims information of AFA Insurance include exposure and pre-injury data; the responses to the questions “What were you doing?”, “What went wrong?” and “How was the injury sustained?” are, since 2005, available for analysis as full free text.

Stout (1998) has showed the benefits of using information from free-text data and how the use of this information resulted in improved claims management in the occupational injury insurance domain. Kolyshkina and Van Rooyen (2006) demonstrated how textual data can be included in the claims analysis and be used to improve the prediction of the pay-out value of insurance claims. Brooks (2008) used ten years of Australian workers' compensation data on the injuries of wood industry workers and delivery drivers to develop a more detailed understanding of hazardous exposures and accident processes with the help of text mining. The

methodology of text mining of extensive occupational injury data is well described this work (Brooks 2008; pp 6-18).

The majority of the recorded claims, which included full free text descriptions, were subjected to a textual analysis (SAS Textmining), which yielded a number of clusters describing exposure scenarios. The process of text analysis, undertaken with the help of this type of software, has been described in detail in earlier studies of large workers' compensation claims materials in Sweden (Larsson et al 2009; Larsson et al 2010a).

3 RESULTS

A total number of 1846 injury cases identified as related to "industrial lift truck, forklift truck", reported as sustained in Sweden in the three year period 2005-2007 were identified. The material includes all sorts of industrial lift trucks - of different size, shape, functionality and construction. Of the injury cases identified, 1783 (97%) contained full free text descriptions and was included in the analysis. The material included one fatal injury. In the following, the N=1783 is considered the total population of industrial lift truck related injuries at work in Sweden 2005-2007.

3.1 Cases by industry

The majority of the lift truck related injuries are sustained in five types of industrial environments; Metal Processing and Manufacturing (30%), Trade and Sales (24%), Transport (15%), Wood, Furniture, Forestry (5%) and Food and Beverages (5%).

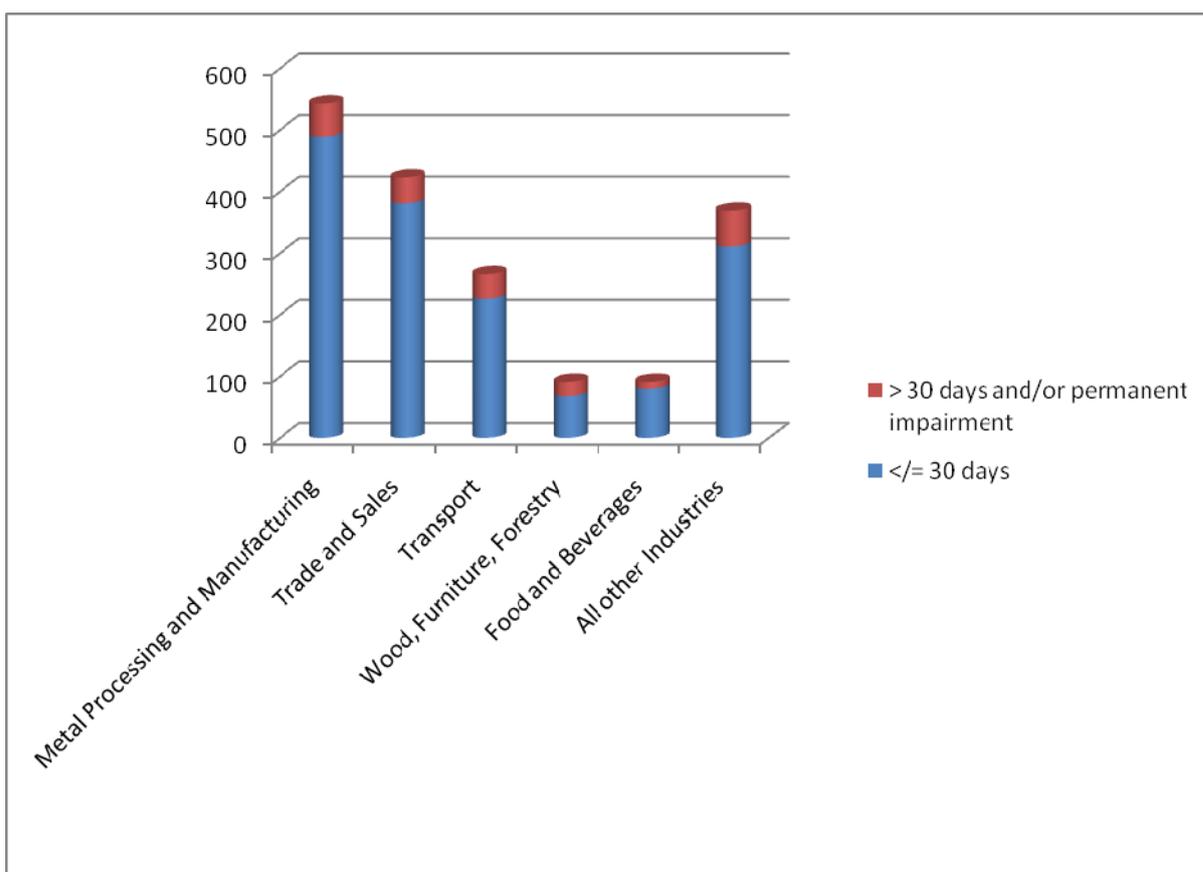


Figure 1 Lift truck related injuries by branch of industry; recorded number of cases and proportion of these with severe consequences (>30 days lost time and/or permanent medical impairment/fatality) N=1783

3.2 Cases by occupation

The occupations most likely to be injured in relation to lift trucks are Storage assistants (28%), Machine and process operators (18.5%) and Forklift truck drivers (18%). A substantial number of Lorry drivers (8%), Repair workers (6%) and Manual order pickers (5%) also figure in the claims material.

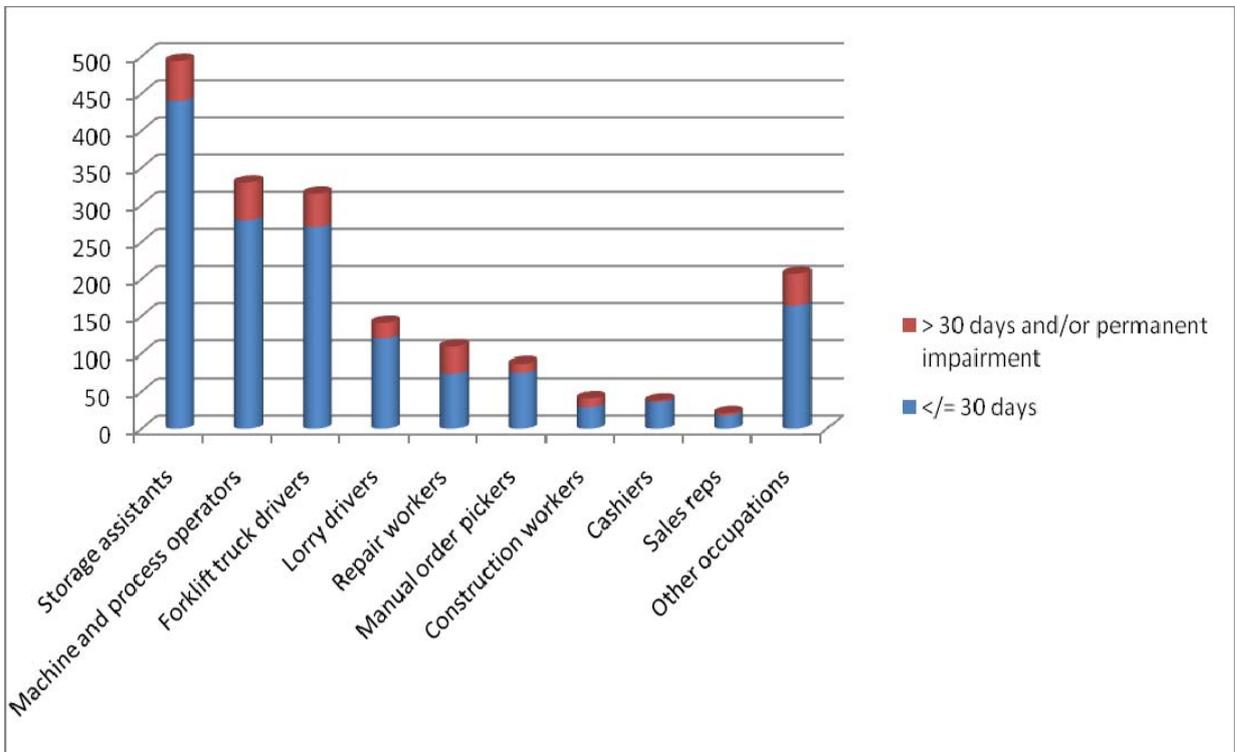


Figure 2 Lift truck related injuries by occupation; recorded number of cases and proportion of these with severe consequences (>30 days lost time and/or permanent medical impairment/fatality) N=1783

If the occupational risk of sustaining a lift truck related injury is set to be 1 among the “Other occupations exposed” of Table 1, i.e. those occupations that figure in the claims material but have less than 20 recorded injury cases over the three year period 2005-2007, then it becomes clear that the occupations mainly working with the lift truck are those exposed to the highest risks of sustaining lift truck related injuries.

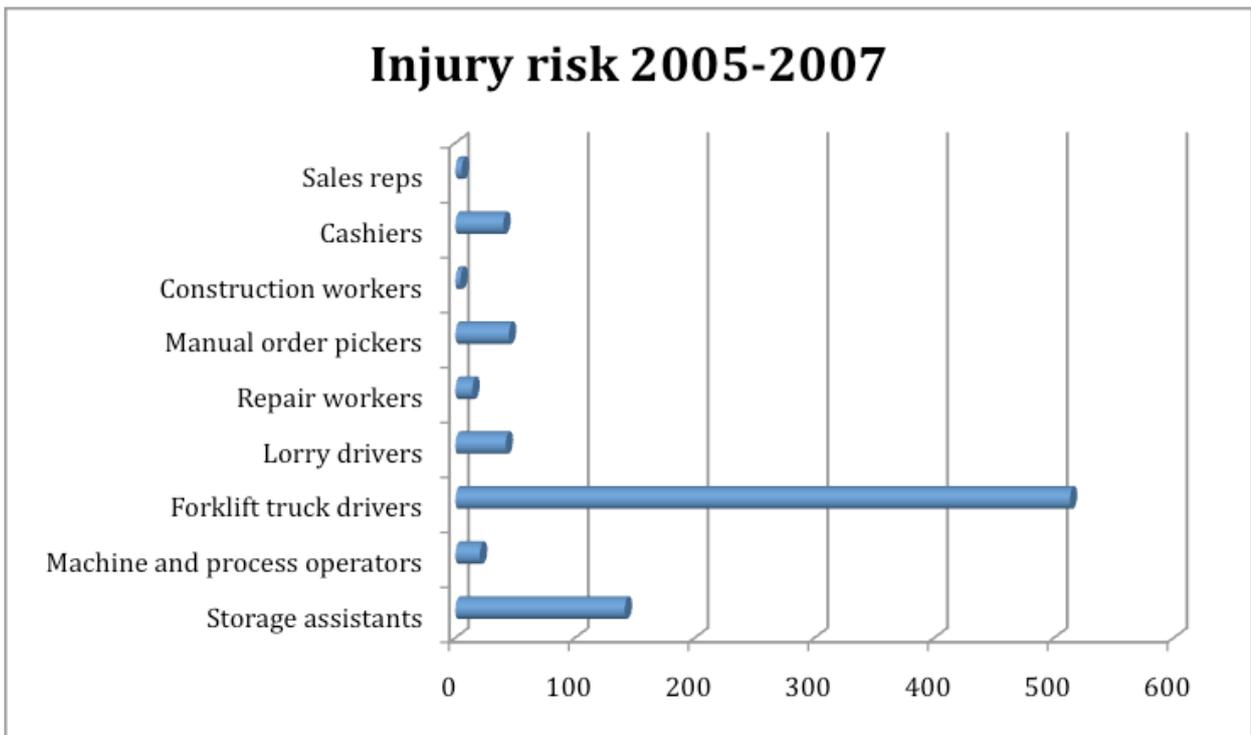


Figure 2b Risk of sustaining a lift truck related injury among occupations with more than 20 recorded such injury cases in Sweden 2005-2007.

3.3 Main exposure scenarios

Four main categories of exposure scenarios have been identified through the analysis of the text information provided in the claims material.

The most common scenario preceding injury is driving the truck. This represents 38% of all lift truck related injuries and it is also the most common exposure scenario in all the major branches of industry and large occupational groups represented in the claims material (Figure 3 through 9).

The distribution of the exposure scenarios varies somewhat between branches of industry. Forklift operators in Trade and Sales industries have quite small proportions of injuries related to handling, adjusting, repairing (Figure 5) whereas this is a much more common scenario among forklift operators in the Transport industries (Figure 6).

Employees working as designated Forklift Truck Drivers seem, not surprisingly, to do very little else (Figure 9).

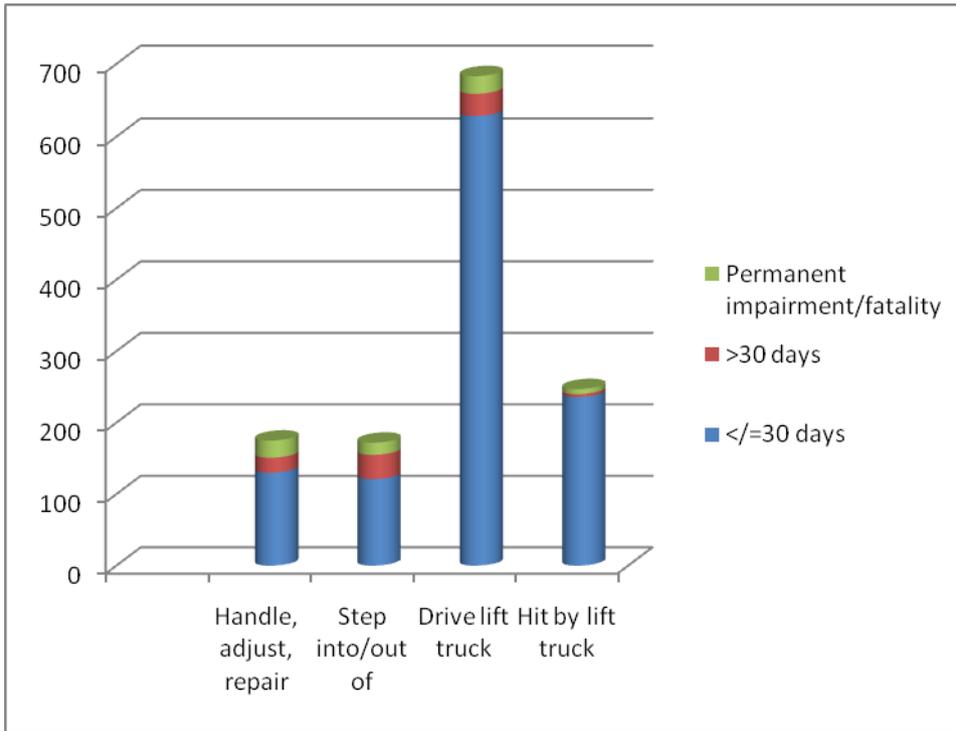


Figure 3 Lift truck related injuries by exposure scenarios in the full material; 1277 cases (72%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

3.3.1 Main exposure scenarios by industry

METAL PROCESSING AND MANUFACTURING

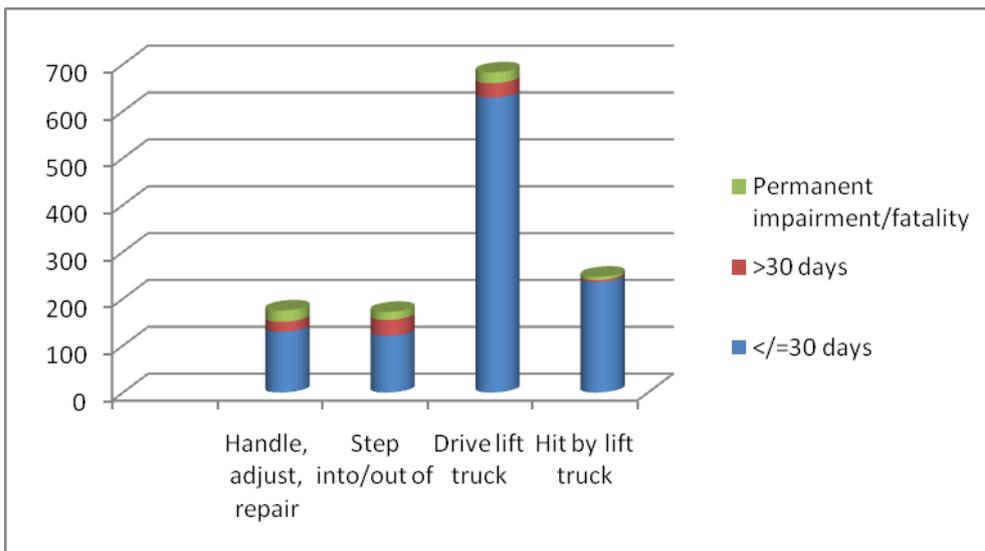


Figure 4 Lift truck related injuries by exposure scenarios for “Metal Process and Manufacturing”; 383 of 543 cases (71%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

TRADE AND SALES

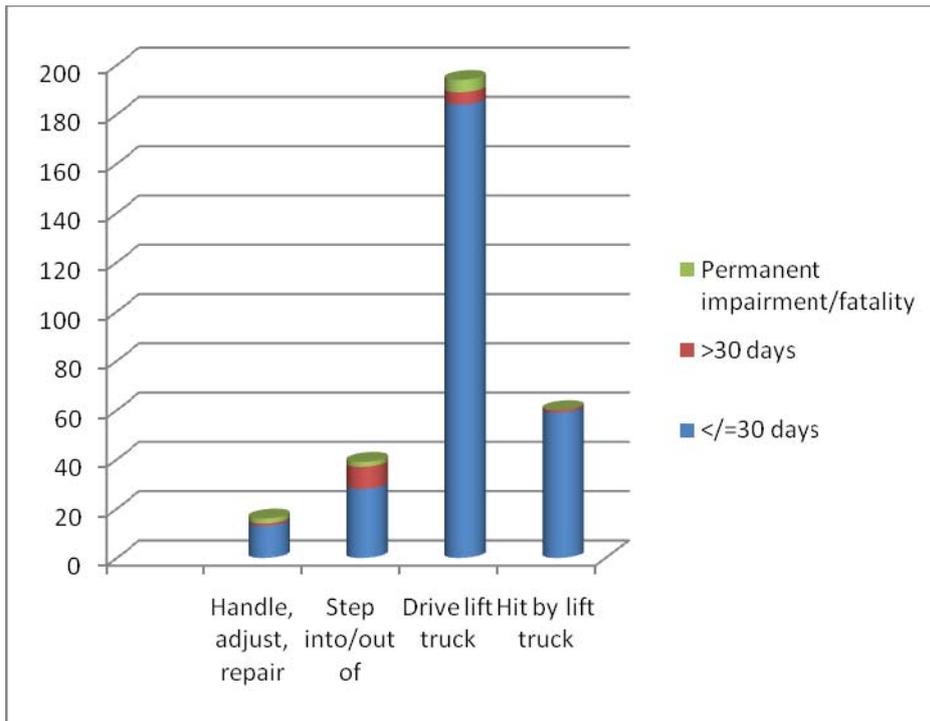


Figure 5 Lift truck related injuries by exposure scenarios for “Trade and Sales”; 311 of 423 cases (74%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

TRANSPORT

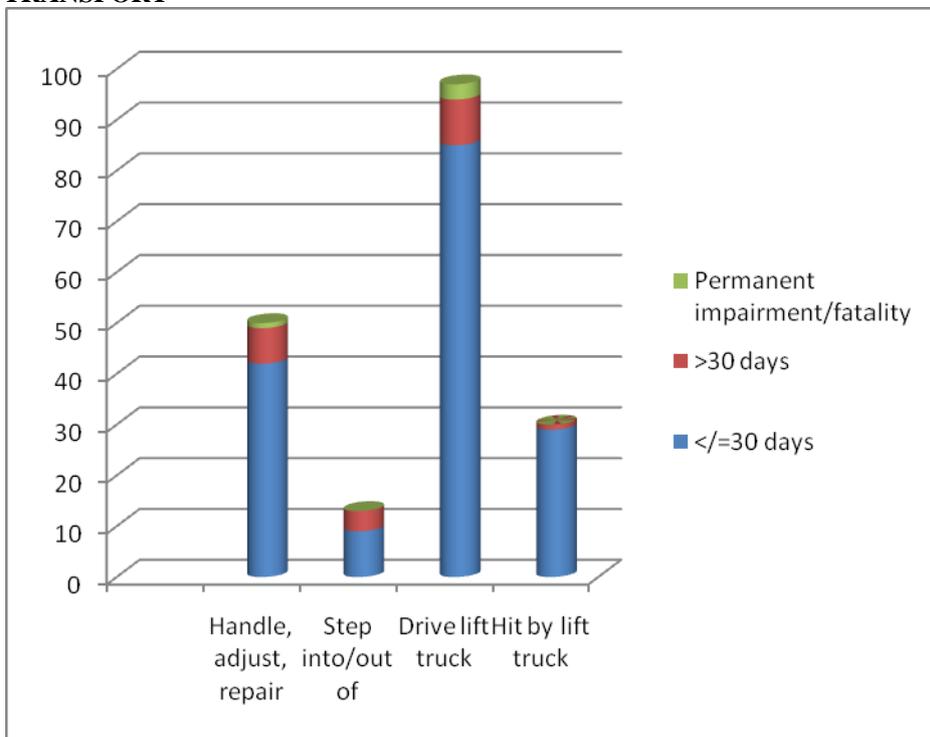


Figure 6 Lift truck related injuries by exposure scenarios for “Transport”; 190 of 266 cases (71%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

3.3.2 Main exposure scenario by occupation

STORAGE ASSISTANTS

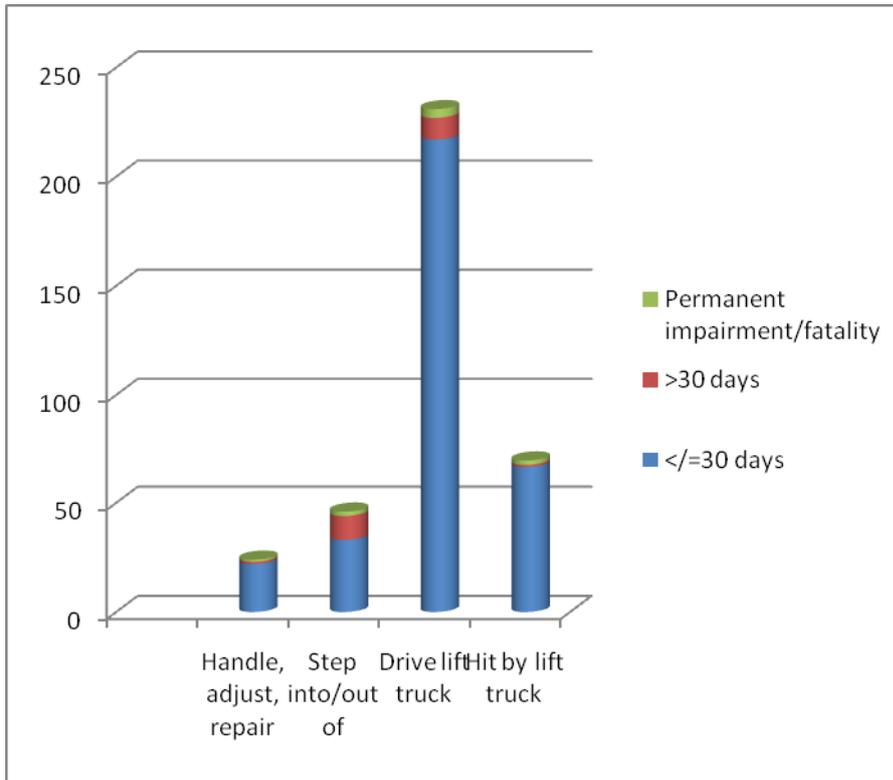


Figure 7 Lift truck related injuries by exposure scenarios for “Storage Assistants”; 371 of 494 cases (75%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

MACHINE AND PROCESS OPERATORS

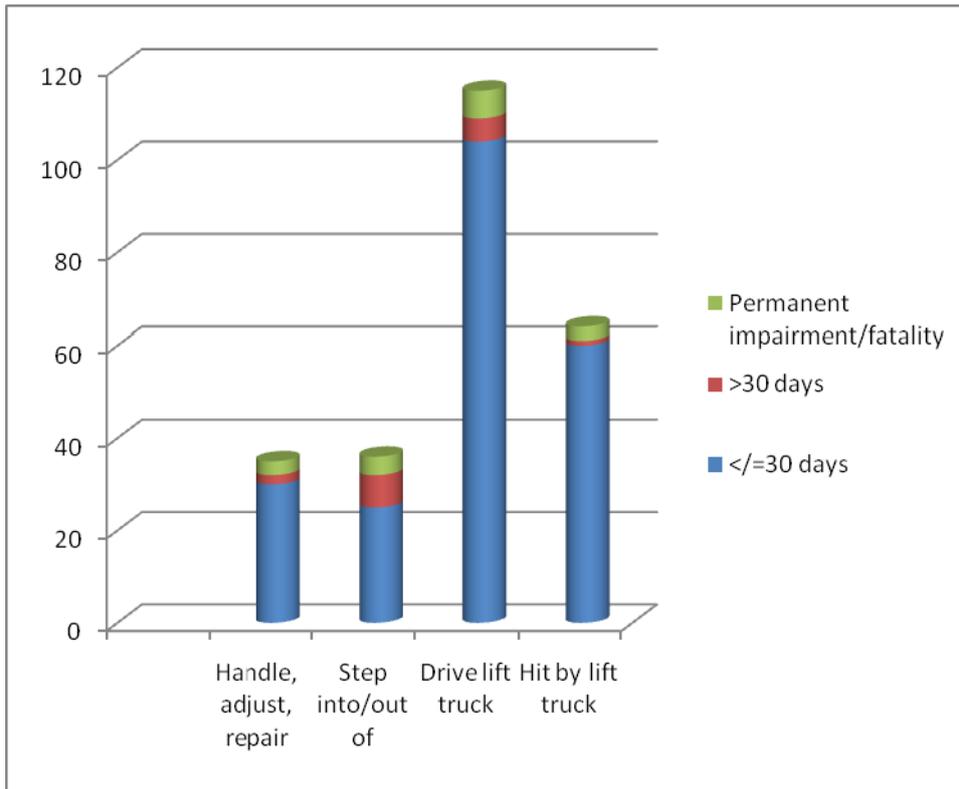


Figure 8 Lift truck related injuries by exposure scenarios for “Machine and Process Operators”; 250 of 330 cases (76%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

FORKLIFT TRUCK DRIVERS

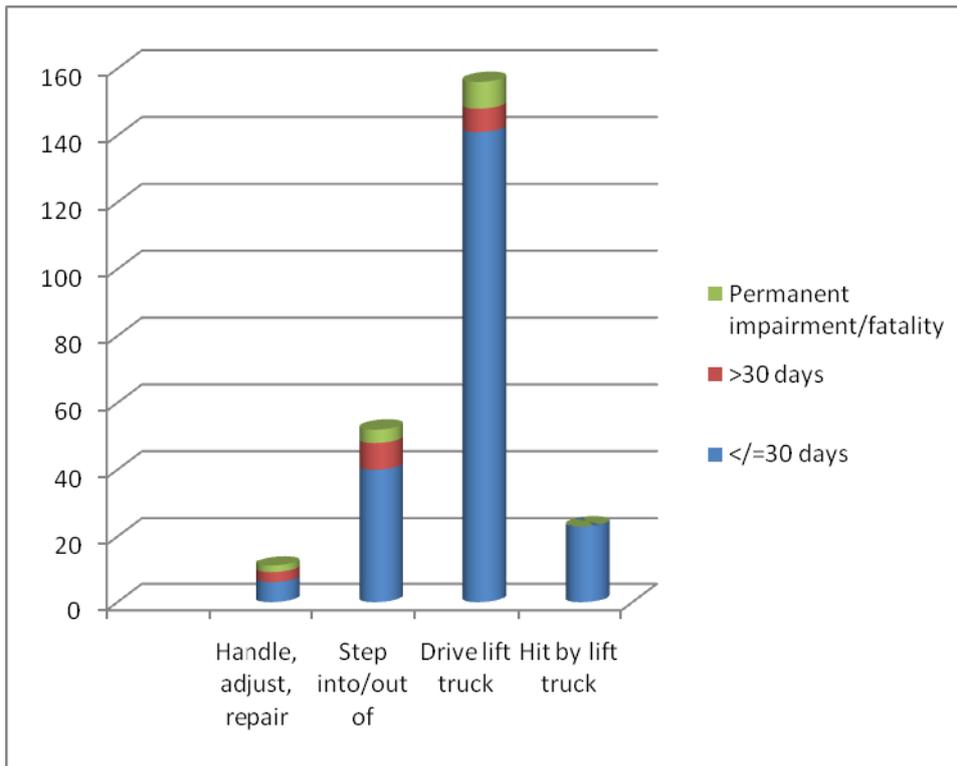


Figure 9 Lift truck related injuries by exposure scenarios for “Forklift Truck Drivers”; 242 of 315 cases (77%) included in the text analysis and proportion of these with severe consequences (>30 days lost time or permanent medical impairment/fatality).

3.4 Driving the truck

The major area of exposure is what is described under the heading of driving the lift truck. This exposure scenario was subjected to further de-aggregation with the help of text analysis. More detailed information on these injuries - 541 of 683 cases (79%) were allocated to clusters - resulted in a number of scenarios identifying prevention measures:

- Falling off, slipping from (n=40)*
 Most cases involve falling off or slipping from the lift truck during order picking. In some cases the driver has fallen off when colliding with structure or other truck. Most common among Storage assistants (Fig 7).
- Jammed (leg, foot, shoulder) between the truck and something else (n=132)*
- Jammed hand/fingers (n=40)*
 All injuries are sustained during normal operations when some part of the operators unprotected extremities are caught between the truck and something else. 25% of the hand/finger injuries result in permanent impairment. Most common among Storage assistants and Machine and process operators (Fig 7, 8).
- Injured knee (n=20)*
 In most cases the knee has been jammed between the truck and something else, in some cases the operator has hit the knee in the truck when driving into something or colliding with another truck. Most common among Storage assistants (Fig 7).

- *Collision between trucks, hit by other truck (n=101)*
Very often hit by other truck from behind. Often reversing and hitting other truck. Incidents evenly distributed among Industries.
- *Driving into, stopping abruptly (n=101)*
Nine out of ten of these injuries happen when the truck hits a gate because the driver has neglected to lower the mast, or because of poor visibility or due to a malfunction of the gates. Most common in Trade and Sales and in Metal Processing and Manufacturing (Fig 4, 5).
- *Load, lift pallet, material or goods (n=90)*
Often miscommunications between lorry driver and lift truck operator in loading bays. Most common among Storage assistants (Fig 7).
- *Forklift overturn (n=17)*
A number of truck overturns and driving over the edge, where operators have survived. Most common in Metal Processing and Manufacturing (Fig 4).

4 DISCUSSION AND CONCLUSIONS

The different use of the lift truck is mirrored in the injury material by the variation in exposure scenarios between industries and occupations (Figures 3 – 9). However, the main injury scenario “drive lift truck” dominates all industries and all occupations. There is a substantial proportion of injuries related to “handle, adjust, repair” in the Transport industry (Fig 6), and a large proportion of “hit by lift truck” among Machine and Process Operators (Fig 8). “Step into/out of” is a prominent injury scenario among Machine and Process Operators (Fig 8) and among Forklift Truck Drivers (Fig 9).

The descriptions of injuries, particularly in the cluster “driving the truck”, indicate that the development of the industrial lift truck has not reached a level of design which provides drivers and pedestrians with passive and active safety features, and that the lift trucks are not equipped with such safety systems which are included standard equipment in a modern vehicle. The design codes for industrial lift trucks are still based on a test for static – not dynamic – stability; no specific rules or criteria on the driver’s safety cage (except that there should be a canopy above his/her head); no included energy absorption crumple zones in the vehicle; no guards for pedestrian feet, no ITS features in relation to safety (ISO 3691; ISO 22915).

From the most clearly identified scenarios in this study, the following conclusions can be drawn:

- lift trucks used for order picking should be built to safely climb on and work from; seating, handles, steps, controls should be designed in accordance with the required actual work tasks and ergonomically acceptable and safe ways to perform these tasks,
- the manufacturers of lift trucks should provide the driver with a safe working position, where no feet, legs, arms, hands or fingers are – or can be – exposed to injury risk by being outside the truck during operations,
- the lift truck driving position should be equipped to provide a safety cage, which prevents hazardous intrusions and penetrations,
- the lift truck driving position should be bolstered and padded in such places where operators tend to hit heads and knees,
- the lift truck wheels should be guarded by passive safety devices preventing pedestrians,
- the operating controls of the lift truck should include an automatic dynamic stability control system, systems for automatic braking and systems for pedestrian recognition.

The results of this study provide detailed evidence for the need of such improved industrial lift truck technology. Industrial lift truck design, and the global lift truck market, should be ready to adopt and develop relevant aspects of modern vehicle safety technology.

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